

NEWS REPORT

W. H. Gardner
NATIONAL ACADEMY OF SCIENCES
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NEWS REPORT

National Academy of Sciences National Research Council

VOLUME IX

September-October 1959

NUMBER 5

The Evaluation and Complexity of Materials Research¹

A. J. HERZIG, *Chairman*
Materials Advisory Board

HISTORIANS have classified periods in man's development according to his use of materials. Thus, it is that we speak of the stone age, the bronze age, the iron age, etc. Some reflection on the subject will probably reveal to you, as it did to us, that stone age man did not, however, devote a substantial amount of time toward the discovery of bronze and that bronze age man likewise did not carefully plan long-range research to achieve the materials which characterize the iron age. It seems that within each of the ages of man, characterized by the use of certain materials, the tendency was to be concerned chiefly with the technique of using the existing materials; to wait for the breakthroughs into new areas of materials science, rather than to plan for the discovery and creation of new materials. I am inclined to think that because such a trend existed for so many years, the problem of materials science in the modern era and especially the administrative aspects of that problem have become especially complicated. The complication comes about not because the technical aspects of materials

science are more involved than the other areas of technology but because man still, by and large, tends to postpone the search for and development of new materials until the need for those materials is on the horizon, if it does not actually already exist.

The formidable argument which can be made, and in which I concur, that anticipation of materials needs invites economic risk does not change the technical character of the problem nor make it any less critical from the point of view of the scientist and technologist. Unfortunately, we find ourselves in the paradoxical situation where the slower processes of research and development in the finite field of materials are all too often not even initiated when the fast-moving technology in the infinite field of design and engineering ingenuity is well underway. Thus, it develops, as is indeed true to a substantial degree in all the other areas of science, that the biggest single factor in the administrative area is the problem of lead time. From the point of view of the materials worker, it is difficult to understand why so much support is forthcoming toward the design of equipment for which no suitable materials are yet known; whereas, support of materials research and development comes in similar intensity only

¹ This article is based on a report presented at the annual meeting of the Division of Engineering and Industrial Research on March 20, 1959. The author is president of the Climax Molybdenum Company of Michigan.

when end-item pressure is upon us. I presume that all materials research and development people wonder why so much confidence exists in the technically hazardous and expensive process of crash research and development for the purpose of condensing time and why so little faith exists in the thesis that recognition of lead time and early initiation of research programs is less hazardous and less costly.

On the other hand, it is quite logical to argue that the infinite field of ingenuity in design will always, and inevitably, overwhelm the finite field of materials science research and development. In my opinion, we are forced to acknowledge then that no ideal solution to the problem exists. We must recognize that we deal in materials science not with a paradox but rather with an enigma. The answers to the questions which arise in the administrative area cannot be obtained by processing data through formulae and equations. Almost invariably, even the limited objectives which can be set up are not static over the period of time involved in materials research and development programs. The broad objective in materials science administration is to assist in minimizing the impact this enigma in materials science can exert on the over-all materials problem in our national technology.

Profound changes in the character of the properties required of materials can result from every new concept in the design of an end-item system. Priorities and emphasis in materials research and development will be in a constant state of flux if these priorities are based on a month-to-month appraisal of current end-item requirements. Yet recognizing that we are in a cycle where designers are in fact limited by the performance of known materials, the national program of research and development in materials science should embrace a more substantial effort in those areas which are longer range in character. Without such provision, it seems certain that we will insure a perpetual state of crisis management in our materials development effort.

The groups most keenly aware of this problem are the armed services. Considering the magnitude of the problem they have faced in the last 20 years, it would be pre-

sumptuous on the part of any civilian to say that they have not done a very fine job in this area. Under an Academy contract with the Office of the Director of Defense, Research and Engineering, the Materials Advisory Board has participated for 7 years in the attempt to solve this problem. Its role is essentially that of trying to assure that an even more comprehensive assessment is made of the materials development problem to supplement the activity of those who have the direct military responsibility.

The Materials Advisory Board is not an operating group. It places no research contracts nor does it conduct research. It provides a means of bringing together competent personnel from universities, industry, and Government, with the objective of achieving the comprehensive assessment which is necessary to generate the soundest possible program based on so many variable factors. The Board is fully aware of the extreme urgency for the development of materials which will insure the successful defense of our nation in a hot war. The Board is keenly aware of the role which materials will play in our capacity to survive in a long-term cold war.

The Board is at present working on over 20 assignments. Three of the major current studies exemplify in different ways the problem of administration of materials science and engineering.

Propulsion systems and a series of vehicle structures are being exposed to higher and higher temperatures, either to permit more effective use of fuel or to increase the performance of the vehicles. A number of metals are potentially useful at these elevated temperatures. These metals, the so-called refractory metals, have varying combinations of strength, ductility, oxidation resistance, modulus of elasticity, fabricability, and other closely related characteristics. The task of bringing these materials to the stage of development that permits their assessment for application is a long, difficult, and costly operation. Accordingly, the Materials Advisory Board undertook, early in 1958, a study of the refractory metals in terms of the national programs required to bring them to a suitable level of production and quality to satisfy a variety of potential applications. As a

result of this study, the armed services and other departments of government will have available a comprehensive statement of the nature of the management and technical problems involved in bringing these little used and new materials to the stage of practicability required for more general application.

A second instance of Materials Advisory Board operations involves the study of thermal protection systems. Many weapons systems are currently being designed to operate in thermal environments in which the total heat input occurs in such a short time that materials selected on the basis of their strength at elevated temperatures would be overwhelmed by the heat input and would melt. With protection from that environment by a radiative shield, by external insulation, or an ablating system, perhaps they could survive. The thermal protection systems involve materials problems, but the nature of these problems is so dependent on the environment that a very detailed analysis of the range of environments was required, ranging from rather low heat fluxes for tens or hundreds of minutes to very high heat fluxes for a few seconds. The range of conditions examined covered the advanced nose cones, and extended to the glide vehicles in the proposed dynasoar system.

A specific requirement that has emerged from this aspect of the study is that materials investigators and administrators must be able to communicate directly with designers to an extent heretofore not felt necessary, in order to interpret technical

requirements and to translate them into materials properties for the guidance of investigators. It is not new that a changing environment places a new requirement for cooperation and liaison of groups that in the past have existed successfully apart, but that requirement must certainly be satisfied in the field of materials for thermal design if practical results are to be achieved.

The Materials Advisory Board is now reviewing the Department of Defense materials research and development effort. An attempt is being made to assess the technical potential from all that is known of materials science in each of the various classes of materials. If funds permit, development of the materials of interesting potential in advance of needs would represent a highly desirable approach. Such programs must be clearly defined.

On the other hand, a better understanding of the development time sequence consistent with the new environments involved in weapons systems now being explored by designers of these systems is necessary. It is not enough to have only the research knowledge of materials if weapons systems designs contemplate their actual use. The development of the processes and fabrication techniques must also precede their application. There is need for an indication of the time available for both the orderly development of the basic knowledge of these materials and the development of their processing and fabrication. If information of this kind can be assembled, the need for crash programs can, perhaps, be materially reduced.

Fracture: A Recent Look at a Vital Topic

B. L. AVERBACH, *Chairman*, and D. K. FELBECK, *Secretary*

Conference on Fracture

THIS Conference grew out of the realization of the need for an effective exchange of ideas and research results among the leading workers in the field of the fracture of solids. A narrative of the origins of this meeting and a description of its opera-

tion may serve two functions: 1) to provide an example of one satisfactory form of international conference, and 2) to serve to point out the needs for more research and better communication within the field of fracture.

Genesis

The traceable origins for this Conference go back at least to 1954, when a review of needed research on ship steel together with recommendations for future studies by C. S. Barrett and W. E. Mahin was published (see Ship Structure Committee Report Serial No. SSC-70, NAS-NRC, 1954). This report was prepared to aid the Committee on Ship Steel, under the chairmanship of John Chipman, in planning the materials research program of the interagency Ship Structure Committee. The authors perceived clearly the need for a careful study of the influence of metallurgical structure on the ductile-to-brittle transition behavior of steel. In two sentences, Barrett and Mahin described a quarter-million-dollar research program: "Therefore *structure* (macro, micro, sub-micro, and atomic) must be considered to be the primary factor and the real subject of the research program. The object of the program should be to isolate the effects of the variables on this metallurgical structure and to understand why they affect the structure as they do and why given structures have the notch toughness they do." Out of this grew a project under the sponsorship of the Ship Structure Committee with the advisory guidance of the Committee on Ship Steel, which has been carried out at the Massachusetts Institute of Technology under the leadership of Morris Cohen and B. L. Averbach.

It was in the course of this study of the influence of metallurgical structure on the transition behavior of ship steel that some discrepancies between behavior as predicted from the prevalent dislocation theories and behavior as measured in the laboratory became quite evident. Fortunately, the research investigators had an opportunity for person-to-person talks with some of the dislocation theorists, for the Ship Structure Committee regularly sends some of its technical people abroad each year to participate in the research commissions of the International Institute of Welding and encourages all possible contacts with researchers in other countries working on related problems. Thus, in 1956, the British school of dislocation proponents was exposed to some of the experimental results

obtained in the program at Massachusetts Institute of Technology; in particular, the local strain preceding fracture in a specimen of mild steel at liquid nitrogen temperature had been found to be more than a thousand times greater than the strain predicted from dislocation theory. There could be no doubt that the theory needed some revision. However, a year later, the 1957 American delegation again found that this discrepancy between theory and experiment persisted.

Thus, in the fall of 1957, a small group that was concerned about this problem met to see what could be done. Present were representatives of the Committee on Ship Steel, the Materials Advisory Board, and research investigators. After hearing a review of developments under the program of the Committee, J. H. Hollomon of the General Electric Research Laboratory noted that his organization had already been planning to hold a conference on the subject of fracture of all kinds of materials; this fact further pointed up the strong need for improved communications within this field. W. J. Harris noted that the Materials Advisory Board's Air Force Study Group that had met at Woods Hole that summer considered fracture to be one of the significant fields of materials research that required more attention. Thus the need for increased emphasis was clear, and the informal committee noted that other recent developments in the field suggested that a major conference would be timely. They anticipated that the paper to be presented by A. H. Cottrell of Cambridge University, England, before the American Institute of Mining, Metallurgical, and Petroleum Engineers, in February 1958, would provide a good initiation point for a subsequent meeting on fracture. (This prediction turned out to be quite accurate.) This informal group then recommended to the Division of Engineering and Industrial Research that a conference on the atomic mechanisms of fracture be held and that appropriate agencies be approached for funds to sponsor such a conference. This Conference was not to be limited to fracture of steel but was to include brittle, ductile, fatigue, and high temperature fracture of metals, ceramics, ionic materials, and polymers.

Planning

Following Academy-Research Council approval of this recommendation, a Committee for the Conference on Fracture was appointed on behalf of E. C. Bain, then Chairman of the Division of Engineering and Industrial Research, with the following membership:

B. L. AVERBACH, Massachusetts Institute of Technology, *Chairman*

R. J. CHARLES, General Electric Research Laboratory

A. H. COTTRELL, University of Cambridge, England

J. R. LOW, JR., General Electric Research Laboratory

T. L. SMITH, Jet Propulsion Laboratory, California Institute of Technology

D. K. FELBECK, National Academy of Sciences-National Research Council, *Secretary*

The National Science Foundation, Office of Naval Research, Air Force Office of Scientific Research, and the Ship Structure Committee served as sponsors. This sponsorship made possible one of the most vital elements of the Conference: namely, the leading workers in the field of fracture could be invited to present papers, regardless of where they were located throughout the world. The Committee could thus anticipate a thorough discussion of theoretical and experimental aspects of this problem among the people most closely associated with it.

Although the Conference had originally been planned as a colloquium of forty or so invited research people working actively in this field, it quickly became apparent that many more people were interested in this topic and would want to participate. However, a substantial increase in the size of the group would prevent achievement of one of the most important goals of the Conference: preparation of a statement of the present state of knowledge and recommendations for future research. Thus it was decided that the Conference would be held in two consecutive parts: the first for the presentation of formal papers in open session with time for discussion, and the second to bring together a working group of about forty people who would attempt to define carefully some of the fracture problems discussed in the first session. General

participation in the open session could be achieved only by preparation of preprint copies of all papers for distribution well in advance of the Conference. With a very large group, discussion is limited, but everyone who wished to prepare discussion in advance of the Conference had an opportunity to present it. In this way the Committee made it possible for recent research work to be presented that was not well known and might otherwise have been omitted.

In planning the technical papers and selecting authors, the Committee made every effort to include representatives of all important points of view and to cover all possible aspects of the atomic mechanisms of fracture. A listing of the best-known research workers in this field indicated that an appreciable percentage of the non-Americans were located in one country, Great Britain, and that many of the Americans were situated in a few organizations. Nevertheless, it was agreed that those most active in this field should be the authors and working participants in the Conference, regardless of the country or group they represented. The response to the invitations was heartening: Of the 40 working participants invited, 38 accepted, and only one of these was unable to be present at the Conference. The chief problem was not in encouraging people to come, but rather in persuading them that there were already more than enough people in the working group.

The Conference thus assumed this final form: Beginning April 12, 1959, five open sessions would take place over a two-and-one-half-day period, followed by three working sessions scheduled during the next two days. A site was selected that was within taxi range of a major airport and yet not so close to a large city as to distract the Conference participants. The New Ocean House, a relatively secluded hotel in Swampscott, Mass., fulfilled the requirements very well. The fact that this hotel had room for over 500 people made possible virtually unlimited registration at the open sessions of the Conference; this was fortunate, because 454 people from 10 different countries registered, whereas the Committee's estimate had been about half that number.

The problems of getting authors to meet deadlines are well known. Because of the very close scheduling of publication of the preprint papers and the desirability of preparing papers in a uniform and legible style, the papers were requested for submission three months in advance of the Conference date. The fact that a 600-page preprint volume was distributed more than a month in advance of the Conference attests to the patience of the harried authors who responded good naturedly when urged to submit their manuscripts. The quality of the manuscripts indicates clearly that, given sufficient advance notice, researchers can prepare outstanding and pertinent discussions of their work, and, with the stimulation of a distinguished audience, are even able to generate new ideas. Distribution of the preprinted papers in advance to all registrants made possible more effective participation in the Conference itself.

Operation

The Conference engendered a tremendous amount of enthusiasm on the part of the participants. No place else can the vitality of this new and growing field be demonstrated better than at a meeting of well-informed individuals deeply interested in the topic. The audience did not weaken in its attention, even after more than two days of tightly scheduled talks.

The working participants, who bore the brunt of fatigue because they were not permitted to return home after the open sessions, continued energetic discussions for another two days. The chairmen of the working sessions—C. S. Barrett, Institute for Study of Metals, University of Chicago; R. W. K. Honeycombe, Department of Metallurgy, University of Sheffield, England; and N. J. Grant, Massachusetts Institute of Technology—spent many late hours preparing their summaries before they left Swampscott. The outcome of their work, as well as the technical content of the papers and discussions, will not be described here because this material will be found in the proceedings of the Conference, which will appear about the same time as this issue of *NEWS REPORT* (see "Fracture: Proceedings of an International Conference on the Atomic Mechanisms of Fracture." Technol-

ogy Press—John Wiley & Sons, Inc., 1959, approx. 640 pp.). It can be stated in general terms that, after 25 years of development of dislocation theories, mechanisms are now being worked out that can satisfactorily explain some of the experimentally observed fracture phenomena. No theory has yet been proposed that explains everything. The working group was, therefore, able to delineate a number of significant areas that need much more attention; and it is hoped that these research areas will be investigated by people in all countries in the world interested in this field.

Potential

We now have available a carefully prepared summary of the current state of knowledge in fracture and a working group that is interested in continuing its contributions to this field. The proceedings of the Conference should aid investigators throughout the world in redirecting their thinking into those areas that appear most promising. The existence of the working group provides an opportunity for continuing the planning and guidance of research work in this field. Before the adjournment of the working sessions of the Conference, the group, on the suggestion of Charles Crussard of the Institut de Recherches de la Siderurgie, France, and Morris Cohen, agreed on the desirability of maintaining the channel of communications that had been established by the Conference. It was agreed that a modest sum of money remaining after the Conference could be wisely used to effect this exchange of information. The working participants agreed that any member of the group who had prepared a short note of interest to the working group could send a copy to the Academy-Research Council office. Duplication and distribution of the note would be quick and easy and would thus provide an opportunity for an informal exchange of ideas within a forum comprised of many of the outstanding workers in the field without the usual delays of formal publication. If the subject of fracture of materials is of sufficient interest to warrant a systematic program, as the outcome of the Conference suggests, one or more agencies responsible

for sponsorship of research work in this field could utilize some of the membership of the working group to establish a continuing Committee on Fracture under the Academy-Research Council, which could plan and guide a long-term research program in a manner similar to that followed effectively for many years by the Committee on Ship Steel under Ship Structure Committee sponsorship. Already pressures

are being applied to the Academy-Research Council to act as a nucleus for an international society for strength and fracture, for there is today no single organization that adequately covers the theoretical and experimental research aspects of this field; such an organization might go far toward promoting effective and continuing exchange of information and stimulation of ideas throughout the world.

SCIENCE NEWS

MILTON CHARLES WINTERNITZ

It is with a deep sense of personal loss that we record the death of Milton C. Winternitz on October 3 at the age of 74. His achievements as a teacher and student of pathology and as Dean of the Yale University School of Medicine, which he rescued and completely reorganized after World War I, have been widely chronicled; but it is as member, advisor, friend, and former Chairman of the Division of Medical Sciences, whose activities have borne his imprint for nearly two decades, that he will be most sorely missed by his associates in the Academy-Research Council.

Dr. Winternitz first became associated with the Division in 1941 as Chairman of the Committee on the Treatment of Gas Casualties; and, when in 1944 this was absorbed into the Office of Scientific Research and Development (OSRD), he became Chief of Division 5 (Chemistry). This led in turn to his postwar service as Chairman of the Advisory and Executive Committees of the Chemical-Biological Coordination Center. He was a charter member of the Committee on Growth, which he was instrumental in founding in 1946, and became its Chairman in 1948. During this period he also served on the Committee on Atomic Casualties, the Committee on Veterans Medical Problems, and the Subcommittee on Oncology, whose Atlas of Tumor Pathology was undertaken on his initiative.

Dr. Winternitz became Acting Chairman of the Division in 1949, during the illness of Lewis H. Weed, and succeeded to the Chairmanship in 1950. During his tenure he was notably successful in fostering mutual understanding and cooperation with the armed services and other agencies. Under his guidance the research aspects of the National Blood Program were reorganized and revitalized, and the Committee on the Army Medical Service Graduate School, the Subcommittee on Stress, and the Committee on Naval Medical Research were established. The creation of the Medical Sciences Information Exchange bore witness to his appreciation of the value of national centers of scientific information, and that of the Committee on Cancer Diagnosis and Therapy to his belief in the social responsibility of science.

After his retirement in 1953, "Winter" remained a vital force in the Division, enlivening its discussions by his outspoken criticism, his penetrating advice, and his intolerance of complacency. He was active as a member of the Executive Committee and of several advisory committees, including the Committee on Dentistry, to which he brought a long-standing interest in the advancement of dental science. In the words addressed to him by the Division on his retirement, he remained to the end a "fruitful contributor to the progress of knowledge * * *, constructive protagonist of experiment in medical education,

victorious pioneer in the breaking of the traditional barriers among the several medical sciences, and catalyst extraordinary for the integration of men and ideas in the service of our country" His honors included the King's Medal in the Cause of Freedom, the President's Certificate of Merit, and a Doctorate of Laws from Yale University.

INTERNATIONAL OCEANOGRAPHIC CONGRESS

More than a thousand oceanographers from large and small nations concerned with the marine sciences assembled in United Nations headquarters during the first two weeks of September to participate in the first international oceanographic congress. Outstanding papers on all aspects of the marine sciences were presented during the morning sessions in the General Assembly Hall, and in the afternoon conferences on various specialized aspects of the oceans were conducted. The program of the Congress included papers which covered the history of the oceans (the physical, chemical, biological, and geological data yielding clues to their origin and growth), the populations of the sea, the deep sea, the boundaries of the sea, and the cycles of organic and inorganic substances in the sea.

The subjects were so arranged as to encourage maximum exchange and participation between the various specialists in the marine sciences. The Congress was co-sponsored by the American Association for the Advancement of Science (AAAS), the International Advisory Committee on Marine Sciences (IACOMS) of Unesco, and the Special Committee on Oceanic Research (SCOR) of the International Council of Scientific Unions. The Academy, through its Committee on Oceanography, participated in the Congress by assisting in the arrangements for a meeting of SCOR prior to and just following the Congress.

Certain of the lectures presented at the Congress will be published in a volume to be made available through the AAAS, and abstracts of the papers presented will also be available when published by the AAAS.

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY

The International Union of Pure and Applied Chemistry (IUPAC) held its 20th Conference at Munich, Germany, August 23-29. The Conference was followed by the 17th International Congress of Chemistry, which was in session from August 30 to September 6.

IUPAC, founded in 1919, has held conferences at 2-year intervals since 1928 except for one interruption in 1932 and a longer one 1938-47, caused by World War II. Since 1949 it has been organized under six sections dealing with physical, inorganic, organic, analytical, biological, and applied chemistry. Each of the sections contains a number of commissions dealing with specialized topics of international interest. Nearly all of the commissions met at Munich.

The United States was represented by the following delegation:

HERBERT E. CARTER, University of Illinois, *Chairman*

JOHN C. BAILAR, JR., University of Illinois

W. CONARD FERNELIUS, Pennsylvania State University

EUGENE G. ROCHOW, Harvard University

FREDERICK D. ROSSINI, Carnegie Institute of Technology

ERNEST H. VOLWILER, Abbott Laboratories International Company and Academy-Research Council

The governing body of the Union is the Council, composed of delegates from each of the adhering countries. At the Munich meeting the Council elected the following officers for 4-year terms: W. Albert Noyes, Jr., University of Rochester, *President*; R. Morf (Switzerland), *Secretary General*; and Sir E. Charles Dodds (Great Britain), *Treasurer*. E. Wichers, National Bureau of Standards, was elected a member of the Bureau for a 2-year term.

Among the more important actions taken by the Council of IUPAC were: 1) the admission of Argentina, Bulgaria, and the Republic of China (Nationalist China) as member countries of the Union; 2) the adoption of a number of recommendations regarding nomenclature, symbols, and terminology; 3) the adoption of a proposal to change the existing scale of atomic

weights to one based on 12 as the atomic weight of carbon isotope-12 (contingent upon the adoption of the same scale by the International Union of Pure and Applied Physics); and 4) the increase of the number of categories of annual contributions of adhering countries from 3 to 6 and the increase of the range of contributions from \$450-\$1,300 to \$450-\$10,000.

The Congress, held in conjunction with the Conference, was primarily devoted to inorganic chemistry, but there were several symposia dealing with special topics in biological chemistry and applied chemistry. In the course of the Congress about 500 papers were presented, nearly 100 of which were by authors from the United States.

The next Conference of the Union will be held in Montreal in 1961. The principal subjects of the Congress held at that time will be physical chemistry and analytical chemistry.

INTERNATIONAL UNION FOR CONSERVATION OF NATURE AND NATURAL RESOURCES

The Seventh General Assembly and technical sessions of the International Union for Conservation of Nature and Natural Resources (IUCN) will be held at Warsaw, Poland, June 14-24, 1960, with field trips during and immediately following the Assembly. The program will include an introductory session on "The Impact of Man and Modern Technology on Nature and Natural Resources." In the technical sessions under the title "Ecological Effects of the Biological and Chemical Control of Undesirable Plants and Animals," attention will be focused on pesticide problems. Additional sessions will be devoted to the theme "Management of Wild Grazing Animals in Temperate Zones and Its Relation to Land Use."

Detailed announcements of the Warsaw meeting may be obtained from the Secretary-General, IUCN, 31 rue Vautier, Brussels, Belgium. Information is also available from the two United States members of the Executive Board of the Union: Harold J. Coolidge, Academy-Research Council; and Edward H. Graham, U. S. Soil Conservation Service.

THE AMSOC COMMITTEE

In 1958 the informal deep-drilling committee of the American Miscellaneous Society (AMSOC) under the chairmanship of Gordon Lill, U. S. Office of Naval Research, was given formal status as the AMSOC Committee of the Division of Earth Sciences. With a grant from the National Science Foundation, the Committee studied the desirability and feasibility of drilling a hole through the earth's crust. On September 8, the Committee reported that it is both desirable and feasible to drill a hole in an ocean basin which will sample all the strata and permit *in situ* geophysical measurements. A specific program of drilling at several possible sites was proposed.

The boring of a hole through the earth's crust has long been a topic of animated discussion among geophysicists and geologists. The project, which has come to be known as the "Mohole," derives its name and its goal from the discovery by Professor Andrija Mohorovičić, a Yugoslavian seismologist, of a transitional boundary between the earth's outer crust and the adjoining mantle at which seismic waves produced by earthquakes suddenly increase in velocity. Obtaining a sample of the earth's mantle will not only provide invaluable clues to the origin and structure of the earth but will also add meaning to the great stores of geophysical data accumulated over the decades. Core samples might well reveal the nature of marine organisms back through the ages to the origin of life itself.

The progress to date has been: 1) the completion of the Committee's basic feasibility studies; 2) a thorough preliminary survey of drill sites near Puerto Rico, under the supervision of the Lamont Geological Observatory and a similar survey between Guadalupe and the Clipperton Islands by Scripps Institution of Oceanography; and 3) a contract with the Global Marine Exploration Company to study the possible adaptation of their drilling ship, *CUSS I*, to deep-water operations.

The Committee is convinced of the feasibility and the tremendous value of such a project. Although scientific objectives will

receive the principal attention, by-products of the project in the form of new technological advances will be of value in other fields.

COMMITTEE ON BIO-ASTRONAUTICS

The Armed Forces-National Research Council Committee on Bio-Astronautics conducted a series of conferences at Woods Hole, Mass., July 15-24. The purpose of these conferences, which included the fourth meeting of the Executive Council of the Committee, was to organize the work of the 10 panels recently appointed within the committee.

The Chairmen and Vice Chairmen of the 10 panels together with the purposes for which the panels were organized are as follows:

1—Panel on Information:

T. C. BYERLY, U. S. Department of Agriculture
S. EDWARD POPE, Armed Services Technical Information Agency

To make available all possible information to users concerned with research, development, and application in the field of bio-astronautics.

2—Panel on Extra-Terrestrial Life:

MELVIN CALVIN, University of California
WOLF VISHNIAC, Yale University

To stimulate and promote all studies concerned with the origin and nature of life in the Solar system and beyond.

3—Panel on Closed Ecological Systems:

HAROLD B. GOTAAS, Northwestern University
CHRISTIAN J. LAMBERTSEN, University of Pennsylvania

To aid in determining what basic information is available and what is needed for the development, design, construction, and maintenance of a closed ecological system containing one or more persons.

4—Panel on Bio-Instrumentation:

OTTO H. SCHMITT, University of Minnesota
WILLIAM R. ADEY, University of California at Los Angeles

To work on the problems of instrumentation incidental to space exploration and its supportive research, as well as those parts of biological phenomenology and analytical technical processes having to do with informational transmission and transductions, data reduction and processing, and control systems.

5—Panel on Acceleration Stress:

JAMES D. HARDY, U. S. Naval Air Development Center, Johnsville, Pa.
CARL C. CLARK, University of Pennsylvania

To review and report upon the research and development problems concerned with the biological effects of mechanical forces which may be of interest in the area of bio-astronautics.

6—Panel on Biological Orientation and Navigation:

SIDNEY R. GALLER, U. S. Office of Naval Research

a) To determine whether investigations in the field of biological orientation could lead to the development of new concepts and the eventual development of electronic and mechanical analogues with capabilities such as detection and identification of targets and long-range navigation; b) to resolve the controversies that have arisen within the last decade regarding the mechanisms by means of which organisms are able to carry out the above functions.

7—Panel on Psychology:

WALTER F. GREYER, Wright Air Development Center
GORDON A. ECKSTRAND, Wright Air Development Center

To study the broad psychological effects of space missions on man, with areas of concern including the role of man in space operations, personnel selection, training, human performance, and the psychological effects of space missions.

8—Panel on Radiation Biology:

HOWARD J. CURTIS, Brookhaven National Laboratories

To collect and evaluate all information concerning the radiation hazard in satellite and interplanetary travel, to explore radiation areas needing further laboratory research, and to recommend radiation experiments to be undertaken in satellites.

9—Panel on Bio-Engineering of Protective Systems:

CAPT. C. F. GELL, U. S. Office of Naval Research
ALFRED M. MAYO, Douglas Aircraft Company

To provide the bio-engineering system data for adequate man-machine performance, and to define, maintain, modify, or replace an artificial closed environment compatible with human survival, effective mental and physical performance, and protection against natural physical forces and hostile enemy action for both primary and emergency situations.

10—Panel on Identification of Long-Range Problems:

BRIG. GEN. DON D. FLICKINGER, USAF (MC), Air Research and Development Command

To take a broad look at the entire field of bio-astronautics, in order to ascertain whether all of the potential problem areas receive proper attention from the other panels. It will act as a group to consider the requirements or needs for specific kinds of research and development activity.

BIOLOGICAL EFFECTS OF ATOMIC RADIATION

The six major committees on the biological effects of atomic radiation, established several years ago by the National Academy of Sciences to consider the principal aspects of this very broad subject, have been continuously active in varying degrees since their initial summary reports of three years ago. Detlev W. Bronk, President of the Academy, has recently asked them to review the entire situation again and to prepare a new report, or series of reports, summarizing their present views on the many questions of biological hazards, thus bringing up to date the first series of reports in the light of current knowledge.

Howard L. Andrews of the National Institutes of Health has agreed to act as coordinator and executive secretary for the study during this period of review, evaluation, and summarization. Dr. Andrews, a distinguished biophysicist who has been a member of one of the committees since its establishment, thus takes over the duties that were shared in the earlier summary study by Charles I. Campbell and Douglas Whitaker.

MARITIME RESEARCH ADVISORY COMMITTEE

Project WALRUS, a summer study, was a principal activity of the Maritime Research Advisory Committee of the Academy-Research Council. This Committee, operating under a contract between the U. S. Maritime Administration and the National Academy of Sciences, has the task of advising that agency on the "nature, organization and prosecution of a scientific research and development program" appropriate to its objectives and responsibilities.

The Committee's Panel on the Wartime Use of the U. S. Merchant Marine, under the chairmanship of Adm. Arthur W. Radford, USN (Ret.), was directly responsible for Project WALRUS. For the purposes of the summer study this 9-man panel was augmented by representatives of civilian government agencies, the military services, and university and industrial research organizations.

Project WALRUS was conducted at the Whitney Estate, Woods Hole, Mass., August 10-28. The average number of participants over the period was about 35. Franklin C. Brooks served as the Technical Director of the Project and Robert B. Keating as the Executive Secretary.

CONFERENCE ON PURE COMPOUNDS

On June 22 and 23, approximately 35 persons from science and industry attended a conference on chemical compounds of certified high purity held at the Academy-Research Council building. The Conference was sponsored jointly by the Academy-Research Council and the National Science Foundation. Frederick D. Rossini, Carnegie Institute of Technology, served as chairman of the organizing committee and of the conference.

The conference was called because of the increasing awareness of the need for a diversity of certified "pure" substances in many areas of biochemistry, chemistry, and physics. Except for a few select substances available from the National Bureau of Standards and a well-known bank of nearly 300 hydrocarbons, most of the chemical compounds used in science and industry are unavailable as samples of certified high purity.

The conference was formally opened by S. D. Cornell, Executive Officer of the Academy-Research Council. Two comprehensive reports set the stage for the discussion period. The first, by Edward Wichers, National Bureau of Standards, reviewed the current program of the Bureau on the preparation of chemical compounds of certified high purity. The second, by Charles L. Thomas, Sun Oil Company, outlined the program of the American Petroleum Institute on hydrocarbons and related substances.

The ensuing discussion was organized under the following headings: 1) Philosophical and Intellectual Aspects of the Problem, 2) Scope of the Conference, 3) Specific Classes of Chemical Compounds Needed, 4) Financial Resources Available for Supporting the Work, and 5) Places to Perform the Work and the Organization to Manage the Operation.

Discussion ranged widely over the many types of pure compounds needed in the physical, biological, and engineering sciences. Difficulties of defining, determining, and maintaining purity were revealed. The productive discussion of the five subject areas was brought into focus by the deliberations of five committees which met separately under the following chairmen:

- 1—BRUNO J. ZWOLINSKI, Carnegie Institute of Technology
- 2—GUY WADDINGTON, Academy-Research Council
- 3—EDWARD F. HILLENBRAND, JR., Union Carbide Chemical Co.
- 4—ALLEN V. ASTIN, National Bureau of Standards
- 5—FARRINGTON DANIELS, University of Wisconsin.

Each committee prepared a separate report and made recommendations, of which some of the more important are:

- 1) An existing organization, such as the Academy-Research Council or the National Bureau of Standards, or both jointly, should establish a permanent information center for compiling and disseminating complete and up-to-date information on existing sources of chemical compounds of certified high purity.
- 2) There should be established at an appropriate institution, such as the National Bureau of Standards, a permanent central technical organization with responsibility for the identification, preparation (if needed), purification (as necessary), and certification of purity of chemical compounds, as well as the general distribution of such compounds at appropriate cost.
- 3) The program should cover the broad spectrum of chemical compounds required by the many branches of science and industry.
- 4) The program should take cognizance not only of the needs and resources of the United States but also those of other countries.
- 5) Government, industry, and individual research investigators should assume their appropriate responsibilities for the financial and scientific aspects of the problem.
- 6) The Academy-Research Council on a national and international basis, in collaboration with the Division of Analytical Chemistry of the American Chemical Society, the appropriate divisions of other societies in the United States, and with the Section of Analytical Chemistry of the International Union of Pure and Applied Chemistry, should *a*) implement improved communication and interchange of ideas and experience among laboratories concerned with the preparation, purification, and purity of chemical compounds, and *b*) encourage research on all aspects of the purity of chemical compounds and on the analytical chemistry pertaining to this work.

A limited number of copies of a report on the conference are available upon request from the Office of Critical Tables, Academy-Research Council.

NATIONAL SCIENCE FOUNDATION FELLOWSHIPS

The Fellowship Office of the Academy-Research Council has again been asked to assist the National Science Foundation with its fellowship programs by receiving and evaluating fellowship applications for the 1960-61 academic year. The Foundation plans to award approximately 1,100 graduate and 125 postdoctoral fellowships in the mathematical, physical, medical, biological, and engineering sciences, including anthropology, psychology (excluding clinical psychology), and the following social sciences: geography, mathematical economics, econometrics, demography, information and communication theory, experimental and quantitative sociology, and the history and philosophy of science. These fellowships are open only to citizens of the United States and are awarded solely on the basis of ability. Fellowships are available to college seniors, graduate and postdoctoral students, and other individuals with equivalent training and experience.

All applicants for graduate (predoctoral) awards will be required to take an examination designed to test scientific aptitude and achievement. This examination, administered by the Educational Testing Service, will be given on January 16, 1960, at designated centers in the United States and certain foreign countries.

The annual stipends for graduate fellows are as follows: \$1,800 for the first year, \$2,000 for the intermediate year, and \$2,200 for the terminal year. The annual stipend for postdoctoral fellows is \$4,500. Limited allowances will also be provided to apply toward tuition, laboratory fees, and travel.

Further information and application forms may be obtained from the Fellowship Office of the Academy-Research Council. Applications for regular postdoctoral fellowships must be received by December 22, 1959, and those for graduate fellowships by January 1, 1960.

FIRST INTERNATIONAL SYMPOSIUM ON FIRE RESEARCH

The tentative program for the first international symposium on fire research to be held at the Academy-Research Council building, November 9 and 10, has been announced by the Committee on Fire Research and the Fire Research Conference. Under the general theme "The Use of Models in Fire Research," individual sessions will be held on 1) modeling principles, 2) two-dimensional fires, 3) full-scale tests, 4) aerodynamics of fires, and 5) experimental techniques.

STAFF APPOINTMENTS

Margaret H. Sloan has been appointed Staff Director of the Committee of Consultants on Medical Research to the Senate Appropriations Subcommittee for the Departments of Labor, and of Health, Education, and Welfare. The Committee will conduct a special study and evaluation of the program of the National Institutes of Health and its effect on medical and dental research and education in this country. The work is expected to take approximately eight months, during which Dr. Sloan will be on leave from her regular duties in connection with the National Blood Program.

The AMSOC Committee has announced the appointment of **Jack I. McLelland** as a staff engineer. Dr. McLelland recently received his Ph. D. degree in engineering from the Bergakademie in Clausthal, Germany, where he worked on the development of a gyrotheodolite for surveying. He served as a steam engineer in the U. S. Merchant Marine during World War II and with the Army Engineer Combat Battalion in the Korean War. His present assignment is to study methods for determining the orientation of drill cores for the Mohole project.

The Building Research Advisory Board has announced three new staff appointments. **Joseph A. Wilkes** became Project Director of the advisory services that BRAB renders the Federal Housing Administration, effective August 1. Mr. Wilkes holds an A. B. degree in chemistry and zoology from Dartmouth College and

a degree in architecture from Columbia University. Prior to joining BRAB, he was an associate professor of architecture at the University of Florida.

On September 2, **Robert W. Spangler** was appointed Associate Staff Engineer to handle the engineering problems assigned by the Federal Housing Administration to the Technical Studies Advisory Committee. Mr. Spangler received his B. S. degree in civil engineering from Virginia Polytechnic Institute.

S. W. Lipsman was appointed Staff Associate, effective August 1, and will be responsible for the management of BRAB publications, information services, and editorial activities. Mr. Lipsman, who has been associated with the Academy-Research Council since January 1957, holds an M. A. degree in English from Columbia University.

The Library has announced the appointment of **Walter M. Whitlow** as editor to revise the two Academy-Research Council publications "Industrial Research Laboratories of the United States" and "Scientific and Technical Societies of the United States and Canada." A graduate of the University of Oklahoma, Mr. Whitlow was with the U. S. Public Health Service before coming to the Academy-Research Council.

A joint secretariat for the Armed Forces-National Research Council Committee on Hearing and Bio-Acoustics and the analogous Committee on Vision has been established by the Academy-Research Council, and **Milton A. Whitcomb** has been appointed Executive Secretary for both committees. Dr. Whitcomb received his Ph. D. degree in psychology from Washington University in St. Louis in 1956 and since then has been an assistant professor of psychology at the University of Texas. He is currently on a year's leave of absence.

Grace L. Iles has been appointed technical assistant for the Foreign Field Research Program of the Division of Earth Sciences. Mrs. Iles received her M.A. degree in chemistry from Maryville College, Tennessee, in 1935. After working for the Office of Naval Research she spent two years in Japan and 18 months in Morocco.

RECORD OF MEETINGS

| July | | July | |
|-------|---|--------|--|
| 1 | Advisory Committee on Ducts Encased in and under Concrete Slabs International Congress on Nutrition, Executive Committee | 23-24 | Advisory Committee on Civil Defense, Subcommittee on Radiation Shielding, <i>Battle Creek, Mich.</i> |
| 2 | Committee on Africa South of the Sahara, <i>New York City</i> Prevention of Deterioration Center, Ad hoc Committee on Department of Defense Environment Handbook | 24 | Committee on Aircraft and Astronautics Applications, Sub-group on Pneumatics, Hydraulics, and Ground Support, <i>Bridgeville, Pa.</i> |
| 6-17 | Materials Advisory Board, Conference of Department of Defense Standing Review Committees, <i>Hanover, N. H.</i> | 28 | Federal Construction Council, Task Group on High Temperature Hot Water Systems |
| 7 | Federal Construction Council, Task Group on Non-Slip Traffic Surfaces | 29 | Federal Construction Council, Operating Committee Maritime Cargo Transportation Conference |
| 7-8 | Ad hoc Committee on Hazards of Pesticides to Wildlife | 30 | Committee on Cnetobiotic and Specific Pathogen Free Animals, <i>Gatlinburg, Tenn.</i> |
| 8 | Committee on Fire Research, <i>Cambridge, Mass.</i> | | |
| 9 | Planning Committee on Architectural Metal Curtain Walls | August | |
| 14 | Committee on Design Criteria for Control of Cracking in Concrete Unit Masonry Construction | 4-5 | Committee for Research in Problems of Sex, <i>Woods Hole, Mass.</i> |
| 15-24 | Armed Forces-National Research Council Committee on Bio-Astronautics, Executive Council and Panels, <i>Woods Hole, Mass.</i> | 6 | Federal Construction Council, Task Group on Underfloor Duct Distribution |
| 16 | Committee on Aircraft and Astronautics Applications, Sub-group on Aircraft and Structures, <i>Denver</i> | 7 | Committee on Sarcoidosis |
| 17 | Federal Construction Council, Task Group on Test Procedures for Underground Conduits | 10-11 | Highway Research Board, Department of Traffic and Operations, <i>Chicago</i> |
| 17-18 | Committee on Astronautics, Sub-group on Propulsion and Auxiliary Power, <i>Denver</i> | 10-12 | Panel on Aircraft and Astronautics Applications, <i>Los Angeles</i> |
| 18 | U. S. Delegation to XXth Conference of International Union of Pure and Applied Chemistry | 11 | Building Research Institute, Committee on Incentives, <i>New York City</i> |
| 20 | Study Committee on Safety to Life in Elementary and Secondary Schools | 13-14 | Committee on Dissemination of Technological Information about Materials and Materials Research |
| 21 | U. S. National Committee, International Union on Crystallography, <i>Ithaca, N. Y.</i> | 17-18 | Highway Research Board, Department of Economics, Finance and Administration |
| 22 | Building Research Advisory Board, Executive Committee Committee on Artificial Respiration | 18 | Committee on Manufacturing Methods Processes, Panel on Electronics, <i>Dayton, Ohio</i> Highway Research Board, Advisory Committee of Bituminous Division, <i>St. Louis</i> |
| 23 | Committee on the Development of Substitutes for Waterfowl Feathers and Down, <i>Natick, Mass.</i> Committee on Scope and Conduct of Materials Research | 18-19 | U. S. Air Force-National Research Council Symposium on Education and Training Media |
| | | 19 | Federal Construction Council, Task Group on Soil Compaction |
| | | 20 | Committee on Atmospheric Sciences Federal Construction Council, Task Group on High Temperature Hot Water Systems |

August

- 20 Study Committee on Safety to Life in Elementary and Secondary Schools, Panel III on Existing Buildings, *New York City*
- 21 Study Committee on Safety to Life in Elementary and Secondary Schools, Panel II on Personnel and Administrative Organization
- 24 Federal Construction Council, Task Group on Non-Slip Traffic Surfaces
- 24-26 Committee on Prosthetics Research and Development, *San Francisco*
- 25 Study Committee on Safety to Life in Elementary and Secondary Schools, Panel I on the Hazards of Fire

August

- 27 Study Committee on Safety to Life in Elementary and Secondary Schools, Panel IV on Proposed School Construction
Federal Construction Council, Task Group on Cold Storage Refrigeration
- 28 Committee on Oceanography
Highway Research Board, Subcommittee on Prestressed Concrete
- 30 U. S. National Committee, International Astronomical Union, *Toronto*
- 31 AASHO Road Test, Subcommittee on the Statement of Fundamental Principles and Project Elements, *La Salle, Ill.*

NEW PUBLICATIONS

Alt, Jean, et al. *Some Aspects of the Antarctic Atmospheric Circulation in 1958*. Washington, 1959. (National Academy of Sciences. IGY World Data Center A. IGY General Report Series No. 4.) 28 p., 82 maps. \$1.00.

Armed Forces-NRC Committee on Vision. *Illumination and Visibility of Radar and Sonar Displays. Proceedings of a Symposium . . . Held at the Smithsonian Auditorium, Washington, D. C., March 31 and April 1, 1958*. Robert H. Brown, Editor. Washington, 1958. (NAS-NRC Publication 595.) 210 p. \$2.50.

Boyd, G. M. *Special Report on Some Observations on the Brittle Fracture Problem*. Washington, NAS-NRC, Ship Structure Committee, 1959. (Serial No. SSC-125.) 20 p.

Culture Methods for Invertebrate Animals. A Compendium Prepared Cooperatively by American Zoologists under the Direction of a Committee from Section F of the American Association for the Advancement of Science . . . New York, Dover Publications, 1959. 590 p. \$2.75. (Preparation made possible by a grant from the National Research Council.)

Digest of Literature on Dielectrics, v. 22, 1958. Washington, NAS-NRC, Conference on Electrical Insulation, Committee on Digest of Literature, 1959. (NAS-NRC Publication 713.) 293 p. \$5.00.

Govan, Francis A., ed. *Underground Heat Distribution Systems. Report . . . for the Federal Construction Council by Task Group T-33*. Washington, NAS-NRC, Building Research Advisory Board, 1959. (NAS-NRC Publication 660. Federal Construction Council, Technical Report No. 3OR.) 37 p. \$1.50.

Keessing, Felix M. *Field Guide to Oceania*. Washington, 1959. (NAS-NRC Publication 701. Committee on International Anthropology, Field Guide Series No. 1.) 51 p. \$1.25.

National Academy of Sciences. *Constitution and Bylaws, July 1, 1959*. Washington, 1959. 24 p.

National Academy of Sciences. IGY World Data Center A. *Rockets and Satellites. Ephemeris of Satellite 1957 Alpha 2 and Collected Reports on Satellite Observations*. Washington, 1959. (IGY Satellite Report Series No. 8.) 122 p. \$1.00.

National Research Council. AMSOC Committee. *Drilling Thru the Earth's Crust. A Study of the Desirability and Feasibility of Drilling a Hole to the Mohorovičić Discontinuity, Conducted by the AMSOC Committee, September 1, 1959*. Washington, 1959. (NAS-NRC Publication 717.) 20 p. \$1.00.

National Research Council. Building Research Advisory Board. *Protection from Moisture for Slab-on-Ground Construction and for Habitable Spaces below Grade. Report No. 15 to the Federal Housing Administration . . . Prepared and Edited by William S. Brown*. Washington, 1959. (NAS-NRC Publication 707.) 66 p. \$1.50.

National Research Council. Building Research Institute. *8th Annual Meeting, A Look to the Future, Research Plans for the 60's and Their Effect on 1970's Buildings*. Washington, NAS-NRC, 1959. [58] p. \$2.00.

National Research Council. Building Research Institute. *Mechanical Fasteners in Building, Presented as a Part of the 8th Annual Meeting of the Building Research Institute, April 1959*. Cleveland, Ohio, Industrial Fasteners Institute, 1959. (*Fasteners*, v. 14, nos. 2 and 3.) 27 p. \$0.25.

National Research Council. Building Research Institute. *Noise Control in Buildings; A Research Correlation Conference . . . January 14 and 15, 1959, Hotel New Yorker, New York, New York*. Washington, 1959. (NAS-NRC Publication 706.) 136 p., illus. \$5.00.

- National Research Council. Building Research Institute. *Sealants for Curtain Walls. A Research Correlation Conference Conducted by the Building Research Institute, April 7 and 8, 1959* . . . Washington, 1959. (NAS-NRC Publication 715.) 82 p. \$3.00.
- National Research Council. Building Research Institute. *Workshop on Windows, Presented by the BRI Building Operation and Maintenance Study Group, BRI 8th Annual Meeting, April 1959*. Washington, 1959. (Reprinted by *Buildings, incorporating National Real Estate Journal*, Cedar Rapids, Iowa.) 20 p. \$0.25.
- National Research Council. Committee on Animal Nutrition. *Joint United States-Canadian Tables of Feed Composition. Nutritional Data for U.S.A. and Canadian Feeds. A Joint Report of Committee on Animal Nutrition, Agricultural Board, National Academy of Sciences-National Research Council, U.S.A., and National Committee on Animal Nutrition, National Advisory Committee on Agricultural Services, Canada*. Washington, 1959. (NAS-NRC Publication 659.) 80 p. \$2.00.
- National Research Council. Committee on Oceanography. *Oceanography 1960 to 1970. 6-New Research Ships; 10-International Cooperation. Chapters of a Report in Progress*. Washington, NAS-NRC, 1959. 20 p. and 8 p.
- National Research Council. Highway Research Board. *A Cooperative Study of Structural Design of Nonrigid Pavements. Review of Test Procedures and Presentation of Rigid Plate Bearing Test Data*. Washington, 1959. (NAS-NRC Publication 676. Highway Research Board Special Report 46.) 56 p., illus. \$1.20.
- National Research Council. Highway Research Board. *Federal-Aid Provisions in State Highway Laws, an Analysis*. Washington, 1959. (NAS-NRC Publication 681. Highway Research Board Special Report 48.) 63 p., illus. \$2.40.
- National Research Council. Highway Research Board. *Ice Melting Properties of Chloride Salt Mixtures* . . . Washington, 1959. (NAS-NRC Publication 679. Highway Research Board Bulletin 220.) 24 p., illus. \$0.50.
- National Research Council. Highway Research Board. *Planning and Development in Urban Transportation-1959* . . . Washington, 1959. (NAS-NRC Publication 680. Highway Research Board Bulletin 221.) 60 p., illus. \$1.20.
- National Research Council. Highway Research Board. *Report on Cooperative Freezing-and-Thawing Tests of Concrete*. Washington, 1959. (NAS-NRC Publication 677.) 67 p., illus. \$1.60.
- National Research Council. Highway Research Board. *Skid Prevention Research* . . . Washington, 1959. (NAS-NRC Publication 678. Highway Research Board Bulletin 219.) 73 p., illus. \$1.40.
- National Research Council. Highway Research Board. *Welded Highway Bridges, Analysis of Inspection Factors*. Washington, 1959. (NAS-NRC Publication 675. Highway Research Board Special Report 45.) 72 p., illus. \$1.60.
- Spilhaus, Athelstan. *Turn to the Sea*. Washington, NAS-NRC, 1959. 44 p., illus.
- Wolfe, Alvin W. *Field Guide to West and Central Africa*. Washington, 1959. (NAS-NRC Publication 702. Committee on International Anthropology, Field Guide Series No. 2.) 40 p. \$1.25.

Notice of Academy Meetings

NATIONAL ACADEMY OF SCIENCES

Autumn Meeting, Indiana University, Bloomington, Ind., November 16-18, 1959
Annual Meeting, Washington, D. C., April 25-27, 1960

NATIONAL RESEARCH COUNCIL

Annual Meeting, Washington, D. C., March 24-26, 1960

NATIONAL ACADEMY OF SCIENCES-NATIONAL RESEARCH COUNCIL

Governing Board, Washington, D. C., October 11, 1959
Governing Board, Washington, D. C., December 13, 1959
Governing Board, Washington, D. C., February 7, 1960
Governing Board, Washington, D. C., April 24, 1960
Governing Board, Washington, D. C., June 12, 1960

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*The search for Truth is in one way hard
and in another easy. For it is evident that no one
can master it fully nor miss it wholly. But each adds
a little to our knowledge of Nature, and from all
the facts assembled there arises a certain grandeur.*

—ARISTOTLE

